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BULLETIN

OF THE

TORREY BOTANICAL CLUB

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Vol. 44 No. 3

BULLETIN

OF THE

TORREY BOTANICAL CLUB

MARCH, 1917.

A revision of the genus Polygonatum in North America

R. R. GATES

(WITH PLATES 4–6)

This genus has been in a very chaotic condition owing to the "lumping" of species, the transference of names, and the confusion of North American with European species. The whole genus contains probably not less than fifty species, the majority of which are European or Asiatic. There has been a marked tendency to form aggregate species of the European forms, so that they too are in need of a critical revision and comparison with North American forms. Not until then will it be possible to determine the closeness of the relationship, though it appears at present that none of the North American species agree with European forms.

The North American forms have been divided by Farwell into two groups, the *Pubescentes* and the *Glabrata*, corresponding respectively to the species which have hitherto been erroneously going under the names *P. biflorum* and *P. commutatum* and which were supposed to comprise all American forms. It may be pointed out that the European alternate-leaved species are also some of them glabrous and some pubescent.

The number of species here recognized is nine, including three, *P. hirtum*, *P. canaliculatum*, and *P. parviflorum*, which are only known from early descriptions. The remaining species show much puzzling variation, so that a number of varieties are recognized, and the limits of variation of several of the species are by no

[The BULLETIN for February (44: 65–116. *pl.* 1–3) was issued February 27, 1917.]

means clear at the present time. The only form which appears to be a possible mutation is *P. giganteum*. The interpretation of the origin and relationships of the other species and varieties will have to await a more detailed knowledge of their characters, variation and distribution.

The Euro-Asian members of the genus *Polygonatum*, however, furnish a series of species, such as *P. verticillatum* All. and *P. Haussknechtii* Bornm. & Sint., which agree in having their leaves in whorls, rather than alternate as in American species or opposite as in some European species. This verticillate condition probably did not come about gradually, and must have appeared as a mutation by a single step. Whether this mutation occurred but once, all verticillate species having then descended from a common stock, cannot be debated at the present time, but this is by no means necessarily the case. The fact of parallel mutations of course complicates all interpretations of phylogenetic possibilities.

Unless otherwise stated the specimens cited below are in the herbarium of the Missouri Botanical Garden. The abbreviation "Cal." signifies the herbarium of the University of California.

1. POLYGONATUM PUBESCENS (Willd.) Pursh

Convallaria pubescens Willd. Hort. Berol. 45. *pl. 45*. 1805.

Polygonatum pubescens Pursh, Fl. Am. Sept. 234. 1814; Farwell, Bull. Torrey Club **42**: 253. *pl. 13A*. 1915.

Polygonatum multiflorum β americanum Hook. Fl. Bor. Amer. **2**: 176. 1840 (in part).

Polygonatum biflorum Ell.; A. Gray, Manual, Ed. 2, 466. 1856.

Salomonia biflora Farwell, Rep. Com. Parks Detroit **11**: 53. 1900.

Polygonatum boreale Greene, Leaflets **1**: 181. 1906. Farwell, Bull. Torrey Club **42**: 253. *pl. 14A*. 1915.

Known from Massachusetts south to Carolina and west to Wisconsin, Michigan and Indiana. The bounds probably extend beyond these limits.

MASSACHUSETTS: Oak Island, May 23, 1897, *J. M. Greenman 2284;* Stony Brook, May 15, 1897, *J. M. Greenman 2288;* Provincetown, May 22, 1904, *J. M. Greenman 3013*. CONNECTICUT: Norwich, May 25, 1883, *W. A. Setchell* (Cal.); Waterbury, June 1,

1888, *Constance G. Dubois* (Cal.). NEW JERSEY: Greenwood Lake, Passaic County, May 19, 1907, *K. K. Mackenzie 2574;* Somerset County, *R. C. Perry.* PENNSYLVANIA: Mountville, May, 1889, *A. F. Eby.* VIRGINIA: Hungry Hollow, northeast of Marion, Smyth County, May 24, 1892, *John K. Small* (Cal.). INDIANA: Harrison Township (Section 30), Wells County, May 14, 1905, *Charles C. Deam* (specimen verging toward var. *cuneatum*); North Lapaz Junction, Marshall County, May 18, 1913, *J. A. Nieuwland 11035.* WISCONSIN: Ephraim, June 5, 1907, *J. M. Greenman 2167;* Appleton, May 15, 1896, *H. P. Chandler* (Cal.). MINNESOTA: Minneapolis, June, 1890, *J. H. Sandberg.*

Farwell has endeavored to separate *P. boreale* Greene from *P. pubescens* on the basis of the somewhat larger and more elliptical leaves of the former, but the variation between them is apparently continuous. Moreover, the two specimens cited above from Greenwood Lake, New Jersey, and Ephraim, Wisconsin, are exactly alike and correspond with the measurements given by Farwell for *P. boreale.* Hence, in the presence of intermediates, both cannot be recognized since they have the same range.

1*a*. POLYGONATUM PUBESCENS CUNEATUM (Greene) Farwell

Polygonatum cuneatum Greene, Leaflets 1: 181. 1906.

Polygonatum pubescens cuneatum Farwell, Bull. Torrey Club 42: 253. *pl. 13, B.* 1915.

Described by Greene from near Turin, Marquette County, Michigan. According to Farwell it differs from *P. pubescens* only in having longer and relatively narrower leaves cuneate at the base. Known from Michigan to Pennsylvania and Connecticut.

CONNECTICUT: Berlin, 1870, *T. S. Brandegee* (Cal. *119680*). PENNSYLVANIA: Bellwood, Blair County, May 18, 1904, *O. E. Jennings* (Cal. *69244*). In these two specimens the leaves are 20–25 mm. wide × 6–9 cm. long, the flowers small, greenish, 8–10 mm. long.

1*b*. **Polygonatum pubescens australe** (Farwell) comb. nov.

Polygonatum boreale australe Farwell, Bull. Torrey Club 42: 254. *pl. 14, B.* 1915.

Known only from Detroit, Michigan, and the following locality:

MASSACHUSETTS: Purgatory Swamp, Westwood, May 14, 1904, *A. H. Moore* (Cal. *158495*). The specimen here cited and photographed (PLATE 4, A) agrees with Farwell's description except that the peduncles are mostly two-flowered. This form is decidedly smaller and more slender than var. *cuneatum*, but may perhaps be connected with it by intermediates. The dimensions of the specimens studied are as follows: stem 1.5–2.5 mm. in diameter, rootstock 4–5 mm. in diameter, leaves pubescent and glaucous below, elliptical, 4.5–6 cm. long, 14–22 mm. wide.

2. POLYGONATUM HIRTUM (Bosc) Pursh

Convallaria hirta Bosc; Poiret, Encyc. 4: 369. 1796.
Polygonatum hirtum Pursh, Fl. Am. Sept. 234. 1814.

This species is unknown at the present time, but there should be no difficulty in identifying it from Poiret's description and the specimens in Paris. It is evidently most nearly related to *P. pubescens*, with which it agrees in having pubescence along the nerves on the ventral surface of the leaves, but from which it differs in that the stem and peduncles are also pubescent. The leaves are described as sessile, nearly amplexicaul, oval, large, ending in a long, obtuse point. The peduncles are said to be an inch long and two- or three-flowered. The size of the flowers can only be determined by examination of the specimens at the Museum d'Histoire Naturelle in Paris. Crevecoeur brought the species from North America to the Jardin des Plantes in 1789.

3. POLYGONATUM BIFLORUM (Walt.) Ell.

Convallaria biflora Walt. Fl. Car. 122. 1788.
Polygonatum angustifolium Pursh, Fl. Am. Sept. 234. 1814.
Polygonatum biflorum Ell. Bot. S. C. & Ga. 1: 393. 1817.
Convallaria angustifolia Schult. Syst. 7: 301. 1829.
Polygonatum multiflorum β americanum Hook. Fl. Bor. Am. 2: 176. 1840 (in part).

Carolina to Pennsylvania.

This species occurs on the Atlantic coast, but its full range is at present unknown. Since the second edition of Gray's Manual, in which *P. pubescens* and other forms were merged with it, *P. biflorum* has been an inclusive species, supposed to range north-

ward to New Brunswick and westward to Kansas and Texas. The precise characters of Walter's *P. biflorum* are difficult of determination. Farwell (*l. c., pl. 15, A*) published a figure of what he believed to be the type of the species, from a specimen collected in Franklin, New Jersey, by H. H. Rusby. I have examined specimens the exact counterpart of this. It is a fairly constant form and I have described it below as *P. biflorum hebetifolium*. It cannot represent Walter's type because that calls for a three-nerved leaf.

What I believe to be the type of Walter's *Convallaria biflora* is represented by a suite of six sheets of specimens, all very uniform, from the Chapman herbarium in the herbarium of the Missouri Botanical Garden. Unfortunately these are without locality, but they doubtless came from somewhere in the southeastern states, probably North Carolina. One of the sheets is represented in PLATE 4, B, and a description of the specimens follows:

Plant glabrous, 2–5 dm. high, naked portion of stem usually shorter than leafy portion. Leaves seven to ten, secund, narrowly elliptic-lanceolate, tapering gradually to a long, narrow point, more acute than in any other American *Polygonatum*, 7–12 cm. long, 8–17 mm. wide, with three to seven more or less prominent nerves, tapering gradually to a semiamplexicaul or sessile base. Peduncles slender (less than 0.5 mm. in diameter) 2–3 cm. in length, bearing one or two flowers on short pedicels 4–6 mm. in length. Flowers yellowish, about 2 cm. long and 3–5 mm. in diameter.

A specimen collected by *C. W. Eisenhower* at Conewago Creek, Pennsylvania, in May, 1898, agrees with the type except that it has somewhat broader leaves (15–21 mm. wide).

3*a*. **Polygonatum biflorum hebetifolium** var. nov.

A specie differt foliis latioribus et obtusioribus (7–10 cm. longis, 13–26 mm. latis), sine nervis manifestis aut solum nervo medio indicato; floribus minoribus, albidis (7–15 mm. longis), frequenter binis, pedicellis usque ad 1 cm. longis.

NEW YORK: Princes Bay, Staten Island, May 25, 1889, *N. L. Britton* (Cal.). NEW JERSEY: Snake Hill, near Hoboken, June 2, 1884, *H. von Schrenk*. PENNSYLVANIA: Mountville, July, 1888, *A. F. Eby;* Mt. Alto, 1909, *Joseph Illick* (flowers 14 mm. long); York County, June 3, 1895, *N. M. Glatfelder* (no flowers);

York County, June 3, 1895, *S. Williams* (no flowers). DISTRICT OF COLUMBIA: Washington, 188–, *L. F. Ward* (Cal.). KENTUCKY: Louisville, 1835, *C. W. Short* (flowers 15 mm. long); Bowling Green, May 29, 1899, *Sadie F. Price*. NORTH CAROLINA: locality, date, and collector's name unknown (specimen in the Chapman herbarium, type). MISSOURI: Watson, June 1, 1894, *B. F. Bush 527*.

One sheet in the Chapman herbarium contains one specimen of typical *P. biflorum* and one of the variety (PLATE 5, A). Hence no doubt they both occur in the same locality. The variety extends as far west as Missouri and its flowers vary somewhat in size, the leaves also showing some variation in relative width and in obtuseness. Indeed I have included a considerable range of forms which may ultimately have to be separated. While in the type specimen the flowers are small and the leaves scattered on the stem, in the Missouri form (PLATE 5, B) the flowers are much larger (18 mm.) and the leaves rather crowded on the stem. A majority of the specimens cited correspond rather more nearly with the latter condition than with the former.

4. POLYGONATUM CANALICULATUM (Muhl.) Pursh

Convallaria canaliculata Muhl.; Willdenow, Hort. Berol. 45. 1805. *Polygonatum canaliculatum* Pursh, Fl. Am. Sept. 234. 1814.

This North American species was described as follows:

Foliis alternis amplexicaulibus oblongis margine pubescentibus, caule canaliculato, pedunculis bifloris axillaribus. Differt a Convallaria pubescenti; foliis oblongis glabris margine tantum tenuissine pubescentibus, corolla magnitudine et facie Convallariae Polygonati.

C. multiflora Michx. (Fl. Bor. Am. 1: 202. 1805) is given as a synonym, from which it may be inferred that the distribution "Pennsylvania to Virginia" given by Michaux applies to *P. canaliculatum*. Although the name *P. canaliculatum* has since been used in various senses, yet the pubescent leaf-margins prevent its identification with any species at present known. Its exact characters should be determined from the original specimens and the careful description given by Schultes (Syst. 7: 1670. 1830).

5. POLYGONATUM COMMUTATUM (J. A. & J. H. Schult.) Dietr.

Convallaria commutatum J. A. & J. H. Schult. Syst. 7: 1671. 1830.

Polygonatum commutatum Dietr.; Otto & Dietr. Gartenz. 3: 223. 1835.

Polygonatum multiflorum β americanum Hook. Fl. Bor. Am. 2: 176. 1840 (in part).

Polygonatum latifolium var. *commutatum* Baker, Jour. Linn. Soc. Bot. 14: 555. 1875.

Polygonatum biflorum commutatum Morong, Mem. Torrey Club 5: 115. 1894.

Salomonia commutata Britton, Man. 273. 1901.

Georgia to Pennsylvania, Wisconsin, South Dakota and Oklahoma, probably extending north into Canada.

This appears to be the most widely distributed of all the species. It varies considerably within the range indicated, and other segregates may be detached from it later. The following specimens in the herbarium of the Missouri Botanical Garden are here referred to it:

PENNSYLVANIA: Conewago, May, 1889, *J. H. Eby;* George School woods, June 2, 1906, *Elma M. Eves.* GEORGIA: cliffs of the Coosa River, Rome, 1872, *A. W. Chapman 3886, 3917.* TENNESSEE: Knoxville, April and May, 1898, *Albert Ruth 148,* 781 (the latter specimen intermediate between *P. commutatum* and *P. biflorum hebetifolium,* leaves 38 × 12 cm.). WISCONSIN: Mirror Lake, Sauck County, July 13, 1903, *H. Eggert.* IOWA: Iowa City, *A. S. Hitchcock.* MISSOURI: St. Louis, June, 1892, *H. Eggert;* Ilasco, August 20, 1911, *John Davis 987.* SOUTH DAKOTA: Vermillion, May 22, 1911, *S. S. Vischer 4018;* Oakwood, *Thomas A. Williams;* Oakwood, May 23, 1902, *A. G. Johnson.* NEBRASKA: Nuckolls County, August, 1899, *George C. Hedgcock* (three sheets); southwest of Lincoln, June 5, 1900, *George C. Hedgcock;* South Bend, May 12, 1900, *George C. Hedgcock.* KANSAS: Cowley County, June, 1898, *Mark White;* Riley County, 1896, *J. B. Norton 834;* Fort Riley, Geary County, July 2, 1895, *C. H. Thompson.* OKLAHOMA: Sapulpa, July 27, 1894, *B. F. Bush 578* ("uncommon").

5*a*. **Polygonatum commutatum virginicum** (Greene) comb. nov.

Polygonatum virginicum Greene, Leaflets 1: 181. 1906.

Polygonatum biflorum virginicum Farwell, Bull. Torrey Club 42: 254. *pl. 15, B.* 1915.

This variety (PLATE 6, A) is evidently closely related to the typical form of *P. commutatum*, from which it differs chiefly in having elliptical leaves, not amplexicaul, dark green in color, and more slender peduncles. Farwell's illustration represents a form of *P. commutatum*.

VIRGINIA: bluffs of the middle fork of the Holston River, near Marion, Smyth County, May 22, 1892, *John K. Small* (Cal. *3835*, co-type of *P. virginicum*). DISTRICT OF COLUMBIA: Dalecarlia Reservoir, May 23, 1905, *Joseph H. Painter 1309*.

5*b*. **Polygonatum commutatum ovatum** (Farwell) comb. nov.

Polygonatum biflorum ovatum Farwell, Bull. Torrey Club **42**: 255. *pl. 16, A*. 1915.

Michigan to Iowa, Nebraska and Oklahoma.

This variety as here understood differs from the species chiefly in having leaves which are amplexicaul, usually rather broadly ovate with very blunt tips, peduncles stout and flattened, flowers frequently in 3's and 4's, about 18 mm. in length. It is clearly related to *P. commutatum* rather than *P. biflorum*.

IOWA: Shelby County, May 30, 1894, *T. J. & M. F. L. Fitzpatrick;* Grinnell, 1886, *H. W. Norris*. NEBRASKA: near Lincoln, June 5, 1900, *George C. Hedgcock*. OKLAHOMA: Catoosa, May 14, 1895, *B. F. Bush 1282* ("common").

6. POLYGONATUM GIGANTEUM Dietr.

Polygonatum giganteum Dietr.; Otto & Dietr. Gartenz. **3**: 222. 1835.

Polygonatum multiflorum β americanum Hook. Fl. Bor. Am. **2**: 176. 1840 (in part).

Polygonatum biflorum γ giganteum Wood. Bot. & Flo. 346. 1870.

Polygonatum canaliculatum giganteum Farwell, Bull. Torrey Club **42**: 256. *pl. 18*. 1915.

Maryland and Pennsylvania to Wisconsin and Montana, south to Nebraska, Missouri and Kentucky.

This species was originally described by Dietrich from specimens received from the Edinburgh Botanic Garden, the superintendent's son having obtained it from North America. It appears to be essentially a giant derivative of *P. commutatum*, yet its characters are sufficiently distinct to be amply worthy of

specific rank. The following specimens, while conforming in general to Dietrich's description, vary somewhat in leaf-shape, length of peduncles, number of flowers, etc., sometimes much exceeding the measurements of the original description. In that description the plants were 3 feet high, though they attained a height of 7½ ft. in the Edinburgh Garden; the peduncles 6–8 lines long, bearing 3–4 flowers on pedicels 4–6 lines long; the leaves oval, glaucous beneath. In the specimens of *P. giganteum* examined, the stem in one case attained a diameter of 2 cm., the (flat) peduncles a length of 11 cm. (bearing as many as nine flowers), the leaves a size of 19 × 10 cm. Most of the specimens were, however, much smaller, though usually larger and with more numerous pedicels than in Dietrich's material. Farwell's specimens (*pl. 18*) from Michigan have smaller flowers (14–16 mm.).

PENNSYLVANIA: Crum Creek near Philadelphia, June 7, 1870, *J. H. Redfield 8187*. DISTRICT OF COLUMBIA: Washington, June 12, 1878, *J. W. Chickering, Jr.* OHIO: Springfield, *M. G. Williams*. ILLINOIS: woody bluffs southeast of East Carondelet, September 4, 1891, *E. Douglas*. WISCONSIN: Racine, September 11, 1879, *J. J. Davis;* Kilbourn, August 15, 1892, *Mrs. Wallace* (leaves 14 × 7.5 cm., broadly elliptical, very obtuse). KENTUCKY; Bowling Green, June, 1899, *Sadie F. Price*. MISSOURI: Woodlawn, September 19, 1878, *G. Engelmann;* Hannibal, May, 1906, *John Davis 12001;* St. Louis, July or August, 1891, collector unnamed. NEBRASKA: Sargent's Hill, June, 1853, *F. V. Hayden;* St. Helena, *T. A. Bruhin;* Lincoln, August, 1889, *H. J. Webber*. Also the following: "A. A. M.," June, 1858 (Herb. Fritchey); "from Niobrarah River to Fort Pierre, June, 1859, *F. V. Hayden* (Reynold's Expedition to the headwaters of the Missouri and Yellowstone Rivers).

7. POLYGONATUM PARVIFLORUM (Poir.) Dietr.

Convallaria parviflora Poir. Encyc. Suppl. 4: 29. 1816.

Polygonatum parviflorum Dietr.; Otto & Dietr. Gartenz. 3: 222. 1835.

This species is unidentified. Its description is as follows:

C. foliis subsessilibus, ovato-oblongis, glabris; pedunculis axillaribus bi-raro trifloris minimis.

The flowers are further said to be small, white, half as large as

in *C. Polygonatum*. The exact features of this plant can only be determined by examination of the original specimen in the Desfontaine herbarium, in Paris.

8. **Polygonatum cobrensis** (Wooton & Standley) comb. nov.

Salomonia cobrensis Wooton & Standley, Contrib. U. S. Nat. Herb. **16**: 113. 1913.

New Mexico.

Through the kindness of Mr. William R. Maxon of the National Herbarium I have been able to examine the type specimen, which came from Copper Mines, Santa Rita, New Mexico. The following specimen (PLATE 6, B), in the herbarium of the Missouri Botanical Garden, came from a neighboring locality and shows still better the features of this species: Pinos Altos Mountains, New Mexico, *E. L. Greene*, May 21, 1880. Dr. Greene referred this specimen to the European *P. vulgare* Desf. which it evidently resembles, though I have seen no specimens of the latter which approach it very closely. A critical comparison should be made with European specimens. The species most resembles *P. biflorum hebetifolium*.

9. POLYGONATUM ELLIPTICUM Farwell

Polygonatum ellipticum Farwell, Bull. Torrey Club **42**: 255. *pl. 16, B*. 1915.

This species was based on material collected by its author at Rochester, Michigan, in June, 1914. Since I have seen no specimens I am unable to judge of its status.

Explanation of plates 4–6

PLATE 4

A. *Polygonatum pubescens australe* (Farwell) Gates. Photograph of a specimen from Purgatory Swamp, Westwood, Massachusetts, *A. H. Moore*. B. *Polygonatum biflorum* (Walt.) Ell. Photograph of a specimen in the Chapman herbarium, presumably representing the type of *Convallaria biflora* Walt.

PLATE 5

Polygonatum biflorum hebetifolium Gates. A. Photograph of a type specimen. B. Photograph of a specimen from Watson, Missouri, *B. F. Bush 527*.

PLATE 6

A. *Polygonatum commutatum virginicum* (Greene) Gates. Photograph of a co-type specimen of *P. virginicum* Greene. B. *Polygonatum cobrensis* (Wooton & Standley) Gates. Photograph of a specimen collected in the Pinos Altos Mountains, New Mexico, *E. L. Greene*.

Some factors influencing the prevalence of Endothia gyrosa

NEIL E. STEVENS

(WITH FIVE TEXT FIGURES)

INTRODUCTION

The distribution of the American species of *Endothia* does not coincide with that of their hosts. Range maps of these species made by Dr. C. L. Shear and the writer as the result of two years collecting, show that *Endothia gyrosa* (Schw.) Fries is abundant in the Southeastern States and has been found occasionally as far north as southern Connecticut and western New York, while two of its hosts, *Fagus* and *Quercus*, occur several hundred miles further north. *Endothia fluens* (Sow.) S. & S., which is common on *Castanea* and *Quercus* from northern Alabama to southern Pennsylvania, has not yet been found north of this region. The territory between Virginia and southern New England appears then to be a transition region for these fungi. Examination of these maps also shows that *Endothia singularis* (H. & P. Syd.) S. & S. and *E. fluens* occupy fairly well defined climatic areas and are apparently not found in America outside these areas. *Endothia gyrosa*, however, while abundant only in the Southeastern States, has been found in Connecticut, New York, Kansas, Texas, and on the Pacific Coast.

The present paper deals with *Endothia gyrosa*, which has a much wider known range in America than any other species of the genus. This fungus is undoubtedly indigenous, having first been collected by Schweinitz at Salem, North Carolina, nearly a century ago, and previous to recent work had been collected at various times in the following widely separated localities: Indiana, 1831 (?), *Schweinitz;* Texas, 1869, *Ravenel;* New York, 1872, *G. W. Clinton;* Florida, 1886–87, *Calkins;* Mississippi, 1887, *Earle;* Kansas, 1887, *Swingle;* Louisiana, 1887, *Langlois;* New Jersey, 1892 (?), *Ellis.*

The intensive collecting of the last few years has not greatly

extended the range of *Endothia gyrosa* beyond that known twenty-five years ago. It may therefore be fairly assumed that this fungus has reached its natural limits of distribution in this country and that the present range is determined by environmental factors, in contrast to fungi which have been recently introduced and have therefore not yet spread throughout the region suitable for their development.

In collaboration with Dr. Shear the writer has prepared a map (FIG. 1), which gives a somewhat more accurate idea of the

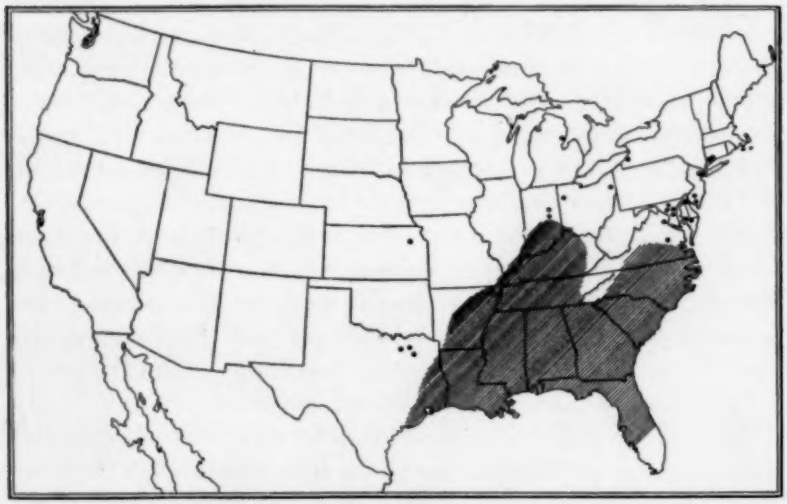

FIG. 1. Known distribution of *Endothia gyrosa*. Cross hatching indicates area in which the fungus is known to be abundant. Dots indicate localities where it has been collected. Map prepared by the writer in collaboration with Dr. C. L. Shear.

distribution of *Endothia gyrosa* than that previously published. The cross hatching indicates the area in which the fungus is known to be abundant, the dots outside that region indicate localities in which the fungus has been collected. In considering the distribution of *E. gyrosa* the problem is double, for the fungus has been found at widely separated localities hundreds of miles outside the region in which it is common. Conditions under which it can exist are not then, necessarily, those under which it will become abundant. The conditions which limit the occurrence

of this fungus have not yet been discovered. The following notes indicate certain factors which seem to influence its prevalence within its present range. In discussing this question observations are confined to the eastern half of the United States, where most of the collecting was done and where, consequently, the distribution of the species is fairly accurately known. This area is particularly favorable for a study of the climatic relations of fungi since, as Ward (11) has pointed out, it constitutes a single climatic subdivision of the country.

INOCULATION EXPERIMENTS

In connection with work already reported (10), inoculations of *E. gyrosa*, *E. fluens* and *E. fluens mississippiensis* were made at various points from Charlottesville, Virginia, to Concord, New Hampshire, in the hope that data might be obtained concerning the effect of climate on their growth. The inoculations were located at points chosen for their availability and their nearness to United States Weather Bureau Stations. These places were visited every five or six weeks during the summer of 1914, twice during the summer of 1915, and once in May, 1916. At each visit ten or more new inoculations were made on species of *Quercus* (sometimes also on *Fagus*) using the method described for previous work (8, 10), and notes were made on the condition of the earlier inoculations. TABLE I gives a brief summary of the results of the observations on *E. gyrosa*.

The results of these inoculations have emphasized four facts, already known. Black oaks (*Erythrobalanus* Spach.) are much more favorable for the growth of *E. gyrosa* than white oaks (*Lepidobalanus* Endl.). *E. gyrosa* will under certain conditions grow and winter over as well near or beyond the northeast limits of its known range as it will within the region where it is most abundant. Water supply is important in the growth of the fungus. The condition of the host is important; this may be, at least in part, only another indication of the importance of the water supply, as obviously the water necessary for growth may be supplied by the host or by the atmosphere.

An examination of the table shows that *Endothia gyrosa* survived the winters of 1914–1915 and 1915–1916 without apparent

TABLE I

Locality	Inoculations made	Pycnidial stromata appeared	Further notes
Charlottesville, Va.	April 20 and May 21, 1914.	Oct. 2, 1914. Abundant especially on tree inoculated May, 1914.	The small tree on which the inoculations of May 1914 were made died during the summer from partial girdling at the time of inoculation. Apparently as a result of this the fungus developed rapidly and produced pycnidial stromata for a distance of 10–12 in. above the point of inoculation.
Fairfax, Va.	April 21 and Aug. 1, 1914.	July, 1914, a few pycnidia on the injured tissue above the inoculations of April. Oct. 24, 1914, fairly abundant and well developed on inoculations of both dates.	
Frederick, Md.	May 30, 1914.	May 21, 1915.	There was no evidence of growth from these inoculations during the summer of 1914. Pycnidia, however, appeared on one branch in the spring of 1915.
Woodstock, Md.	May 30 and July 30, 1914.	Oct. 19, 1914.	While both these inoculations showed considerable development of pycnidial stromata they were less than some others both further north and further south.
Wilmington, Del.	July 6, 1914.	Oct. 6, 1914.	Large well-developed stromata, which showed no change during the succeeding summer.
Hartford, Conn.	July 15, 1914. Sep. 24, 1914.	Sept. 23, 1914. A very few stromata. Aug. 18, 1915, large well-developed stromata.	In this case stromata developed abundantly during the summer of 1915 from inoculations which during the summer of 1914 showed only a few scattering stromata.
Amherst, Mass.	July 15, 1914.	Sept. 24, 1914.	This inoculation became contaminated later with *Endothia parasitica*.
Williamstown, Mass.	July 14, Sept. 24, 1914, & May 21, 1915.	Aug. 16, 1915.	The small oak on which the inoculations of July 1914 were made was killed by the cuts and bore numerous large pycnidia of this fungus during the summer of 1915. None of the inoculations made at this point produced stromata during the summer of 1914.

TABLE I—*Continued*

Locality	Inoculations made	Pycnidial stromata appeared	Further notes
Concord, N. H.	Sept. 22, 1914 May 18, 1915.	Aug. 19, 1915.	Several good sized pycnidial stromata developed on several of the inoculations of both these dates.
Stations on Overlook Mt., Woodstock, N. Y.			
Station / Elevation in feet			
S 3 1,000	June 12, 1914.	Aug. 14, 1915.	Pycnidial stromata appeared from one inoculation during the summer of 1915, though there had been no evidence of development during the summer of 1914.
C 1,500	June 13 & Sep. 30, 1914.	Aug. 11, 1915.	Abundant large pycnidial stromata developed during the summer of 1915, although none had developed during the summer of 1914.
O 6 1,500	June 11, Jul. 8, Aug. 12, 1914.	May 25, 1915. From inoculations of June, 1914; and Aug. 12, 1915, from inoculations of July and Aug. 1914.	
O 1 1,900	June 11, 1914. July 9, 1914.	Sept. 29, 1914.	These showed the greatest development of any stromata of *E. gyrosa* in the entire series of inoculations. Abundant pycnidial stromata developed extending 1–6 in. above and below the cut in each inoculation. There was continued growth but no perithecia had developed up to May 1916.
O 4 2,800	July 9, 1914.	May 26, 1915.	Numerous stromata developed well beyond the cut and extending for a foot or more above and below the place of inoculation. These were alive and in good condition May 1916, but had produced no perithecia.

All the inoculations listed above as having developed pycnidial stromata were alive in May, 1916, but no perithecia had developed.

injury in the most northern localities at which inoculations were made, i. e., Williamstown, Massachusetts, and Concord, New Hampshire, and at an elevation of 2,800 feet on Overlook Moun-

tain. Its growth in these localities was nearly, if not quite, equal to that at more southern points.

The effect of abundant moisture is readily seen from the fact that at Concord, Williamstown, and two stations, S 3 and C, on Overlook Mountain, stromata developed in 1915 from inoculations which had shown no growth in 1914; as well as by the fact that at Hartford, Connecticut, stromata developed abundantly during the summer of 1915 from inoculations which during the summer of 1914 showed only a few scattered stromata. As the weather conditions of the two summers in these localities have been discussed in detail by the writer elsewhere (10) it may merely be stated here that there was little difference in the temperature but that the rainfall of 1914 was much below normal; that of 1915 well above normal.

The importance of the condition of the host in the growth of *Endothia gyrosa* was best seen at Charlottesville, Virginia,* where the small tree which was inoculated gradually died from the effect of the cuts and the fungus developed rapidly and produced stromata for a considerable distance above and below the point of inoculation. The growth of the fungus on this tree was much greater than that on any of the trees which survived the wounds made by inoculations. The peculiar relations between this fungus and its host have been referred to elsewhere (8). In general it has been observed that tissue injured by cuts or bruises in such a way that it does not dry out immediately but remains in a living condition for some time is the most favorable place for the development of this fungus. Such a condition is found on the stubs of cut limbs, on bruised or broken trunks, and especially on exposed roots which have been injured by tramping of cattle or by other means. This habit of the fungus seems to materially affect its distribution.

CLIMATIC RELATIONS

Temperature.—The range of temperature favorable for the growth of *E. gyrosa* in artificial media seems to be almost identical with that of *E. parasitica* (8). The writer has recently demonstrated (10) that during the years ending in May and August,

* The inoculations and some of the observations at this point were made by G. F. Gravatt.

1915, *Endothia parasitica* made almost twice the lateral growth on *Castanea dentata* in Virginia that it made in New England. This difference in growth is closely correlated with the difference in temperature of the two regions. It seems very probable, therefore, that the more favorable temperature of the Southern States favors the more abundant growth of *E. gyrosa* in that region.

A comparison of the map (FIG. 1) of the distribution of *E. gyrosa* with climatic maps shows certain general correlations. Much of the region where *E. gyrosa* is most abundant lies south of the isotherm of 6,000 temperature summation and the closely similar isotherm of 600 temperature efficiency as calculated by the Livingstons (**7**). Much of the region where *E. gyrosa* is most abundant lies within or south of the area of eight months (April to November) vegetation, as mapped by Zon (**12**).

It is significant, however, that the area in which *E. gyrosa* is abundant does not agree closely with any of these lines. The fungus is abundant considerably north of the line of 600 temperature efficiency in Kentucky and southern Indiana but falls far short of this isotherm in eastern Virginia. The same relation exists between the area in which *E. gyrosa* is abundant and the isotherm 10,000 as given by Livingston (**6**) in his chart based on physiological summation indices of temperature efficiency for plant growth (**6**, *f. 2*). Similarly, the northern limit of the area of abundance coincides closely with the limit of eight months vegetation in Virginia, but runs well toward the middle of the area of seven months vegetation in Kentucky and Indiana. Moreover, as has been stated above, the temperature of New England in the region of six months vegetation is evidently sufficient for the growth of *E. gyrosa* under some circumstances.

On the other hand, *Endothia gyrosa* is not perceptibly more abundant in the areas of nine to twelve months vegetation, i. e., southern Mississippi, Alabama, and Florida, than it is in certain portions of the area of seven months vegetation, i. e., Kentucky and southern Indiana. It would seem then that temperature alone is not very significant in determining the abundance of this fungus.

Precipitation.—One of the most important climatic factors influencing the abundance of *E. gyrosa* in the Southern States is

probably the greater rainfall, especially during the growing season. The rainfall of the eastern United States during the growing season is given by Henry (5). In general, the area where *E. gyrosa* is abundant is largely in or south of the region of twenty-five inches rainfall, April to September, inclusive. An exception to this is found in Tennessee, Kentucky and southern Indiana, which are well outside the area of twenty-five inches rainfall, but where *E. gyrosa* is fully as abundant as in the region of over thirty inches rainfall.

The striking fact has recently been pointed out by Ward (11), that in the eastern United States no sudden changes in climate are met with in going from north to south, but the transitions are everywhere slow and gradual. On the other hand, there is a fairly definite line of demarcation between the area in which *E. gyrosa* is abundant and the area where it is rare. This seems to indicate that factors other than temperature and rainfall markedly affect the prevalence of this fungus.

That *E. gyrosa* is abundant in southern Indiana where the climate is both drier and cooler than in most regions where the fungus is commonly found, seems to be due to greater opportunity for infection. As has been pointed out in an earlier paper (8), southern Indiana is a stock-raising region where pastures containing beech trees are numerous. Nearly all of the collections of *E. gyrosa* in this region were found in such pastures on the roots of beech which had been injured by cattle. The importance of such opportunity for infection is emphasized by the condition found at Columbiana, Ohio, in June, 1913. This locality is several hundred miles outside the area in which *E. gyrosa* is commonly found in abundance, yet in a single pasture where there were from fifteen to twenty large beech trees many of whose roots were exposed and had been injured by trampling of cattle, the writer found this fungus abundant in more than twenty small patches.

OPPORTUNITY FOR INFECTION

Field observations have convinced the writer that opportunity for the infection of its hosts is of the greatest importance in determining the prevalence of *E. gyrosa* and that the greater abundance of *E. gyrosa* in the southern states is largely accounted for by the

greater opportunity for infection in that region, aided by more favorable temperature and more abundant rainfall. Other things being equal, the more frequent the occurrence of places favorable for its growth the more abundant a fungus will become. This process is cumulative, for the more prevalent a fungus the more completely it will occupy the available places of infection.

Greater opportunity for infection in the south is due to the greater number of host species and to the greater importance of these species relative to other trees. And especially to greater opportunity for the infection of individual hosts from injuries due to different climatic, soil and cultural conditions.

HOST RELATIONS

Endothia gyrosa is found commonly in the United States on hosts of four genera: *Castanea*, *Fagus*, *Liquidambar*, and *Quercus* —least abundantly on *Castanea*, most abundantly on *Quercus*— the collections made in the work already referred to (**8**) being in the following numbers: *Castanea*, 18; *Fagus*, 47; *Liquidambar*, 49; *Quercus*, 158. Actually the fungus is much less frequent on *Castanea* than is indicated by these figures, since the eighteen collections represent all the cases in which *E. gyrosa* was found on *Castanea*, while the number of collections on the other hosts represent simply a few specimens from each locality visited and could have been increased many times.

Endothia gyrosa has been collected by Dr. Shear and the writer on the following species of *Quercus: Q. alba* L., *Q. coccinea* Muench., *Q. digitata* (Marsh.) Sudworth, *Q. georgiana* Curtis, *Q. imbricaria* Michx., *Q. marilandica* Muench., *Q. nigra* L., *Q. phellos* L., *Q. Prinus* L., *Q. rubra* L., *Q. velutina* Lam., *Q. virginiana* Mill. From the first, however, it was obvious that the fungus was more abundant on the various species of black oaks than on the species belonging to the white oak section of the genus. Of the 158 specimens from all parts of the United States which were collected, eighty are known to be on species of black oak, nineteen on species of white oak. The specimens, for which the host species is not given, are apparently divided in about the same ratio. These unidentified specimens are chiefly from the southern states where the collecting was done largely in midwinter.

RANGES OF HOST SPECIES

The maps, FIGS. 2–4, show the ranges of the various host species: FIG. 2, the ranges of *Castanea*, *Liquidambar* and *Fagus;* FIGS. 3 and 4, the ranges of the species of *Quercus* on which *E.*

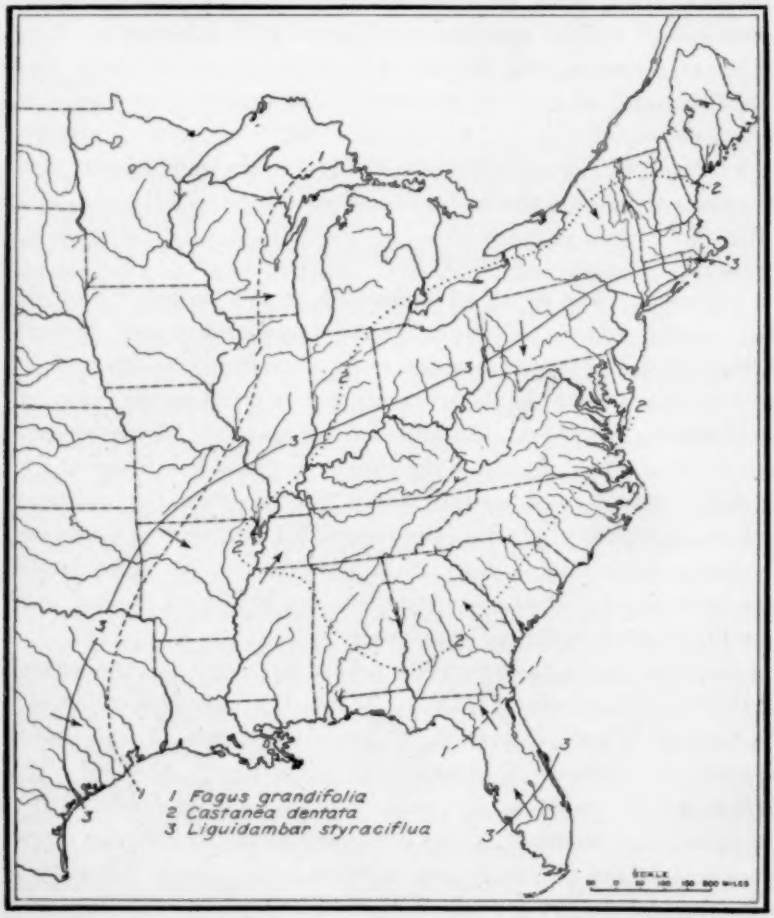

FIG. 2. Ranges of *Fagus grandifolia*, *Castanea dentata*, and *Liquidambar Styraciflua* in the United States. Map prepared by W. H. Lamb, United States Forest Service.

gyrosa is known to occur. A comparison of the range maps shows that certain of the host species, i. e., *Castanea dentata*, *Fagus grandifolia*, *Quercus alba*, *Q. coccinea*, *Q. falcata*, *Q. Prinus*, *Q.*

rubra, and *Q. velutina*, extend well beyond the known range of *E. gyrosa*.

In considering the prevalence of a fungus, however, not only the occurrence of its hosts, but their relative abundance must be considered. In general, a fungus will be more abundant in a given locality the more numerous are the favorable hosts. The fact is generally recognized in horticultural practice that an isolated plantation is more likely to escape disease than one close to other similar plantations. It is to be expected then that *E. gyrosa* would be found most abundantly where its favorite hosts are most numerous, and this is actually the case.

FOREST REGIONS

A glance at the map of the forest regions of the United States issued by the Forest Service shows that the region in which *E. gyrosa* is most abundant comprises the southern forest and portions of the central forest. The following brief descriptions of the three forest regions under consideration are taken from the Forest Service map of the "Forest Region of the United States," issued in 1910:

Northern forest (northern portion): White, red and jack pines, spruces, firs (balsam), poplars and aspens, birches, tamarack.

(Southeastern portion): Maples, beech, birches, aspen, chestnut, white, red, and scrub pines, spruces, fir (balsam), hemlocks, tamarack, arbor-vitae.

Central forest. White, black and red oaks, hickories, chestnut, walnut, and butternut, yellow poplar, cherry, ashes, elms, maples, beech, locust, buckeyes, cottonwood.

Southern forest. Yellow pines, white, live, red, and black oaks, hickories, cypresses, white cedar, juniper, red and tupelo gums, magnolias, bays, elms, hollies, ashes.

In both the forest regions in which *E. gyrosa* is abundant, its favorite hosts, white, black and red oaks (*Quercus* spp.), together with beech (*Fagus*), in the central forest, and red gum (*Liquidambar*) in the southern, are included among the characteristic species.

In the northern forest beech is the only host of *E. gyrosa* mentioned among the characteristic trees, and even beech only in the southern portion. It is evident then that though several

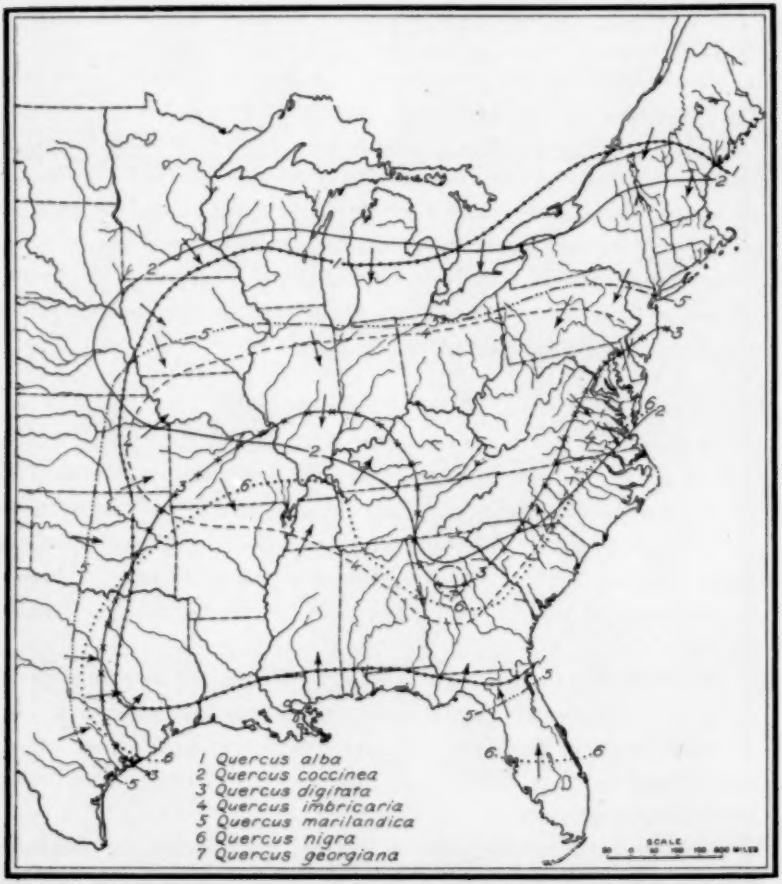

FIG. 3. Ranges of several species of *Quercus* in the United States. Map prepared by W. H. Lamb.

of the host species of *E. gyrosa* extend considerably north of the region where this fungus has been found they no longer predominate.

The relative importance of hosts of *E. gyrosa* among the northern hardwoods is well brought out in a recent report by Frothingham (3, p. 6), in which the species comprising the northern hardwood forest are grouped according to their prevalence as characteristic, locally characteristic, or occasional. Of the hosts of *E. gyrosa* only beech appears among the characteristic and only

FIG. 4. Ranges of several other species of *Quercus* in the United States. Map prepared by W. H. Lamb.

red oak among the locally characteristic species. It is suggestive that in only one locality, Central Michigan, has *E. gyrosa* been found in the northern forest, especially as that region in New York, Pennsylvania, Maryland, and adjoining portions of West Virginia has been the scene of much recent collecting in connection with work on chestnut blight. There seems to be no climatic reason why *E. gyrosa* should not occur on beech in the northern states of New England, and the writer believes it may yet be found there. Host relations alone would, however, prevent its becoming prevalent.

SOIL RELATIONS

Within the Central and Southern Forest Regions where its hosts are abundant, the relative amount of opportunity for infection is greatly influenced by soil and cultural conditions. As has already been mentioned, exposed and injured roots of *Fagus* and

Quercus are by far the most favorable places for infection of *E. gyrosa*. In the southern states climatic and cultural conditions combine to make such exposed roots very much more common than in the northern states.

EROSION

The difference in soil erosion alone would largely account for the much greater abundance of exposed roots in the south. While no accurate data as to the relative erosion in various parts of the country are at hand, a review of the literature of the subject

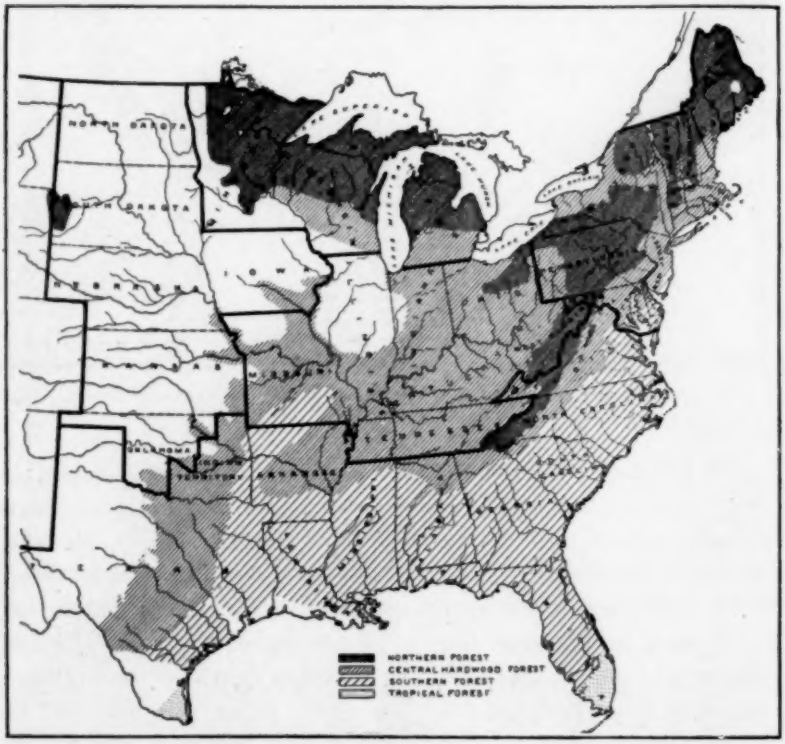

FIG. 5. Forest regions of the eastern United States. Map supplied by United States Forest Service.

shows clearly that in the states of Virginia, Kentucky, Tennessee, North and South Carolina, Alabama, Georgia, Louisiana, and Arkansas soil erosion is a serious problem. Davis in a recent review (**2**) of the subject calls attention to the fact that throughout

the south erosion is worse than in other sections of the country and suggests that "it is probable that the climate has much to do with the fact that erosion is so rapid in the south. The character of the soil makes a marked difference in the rates of erosion under the same climatic conditions."

SNOW-COVER

The abundant rainfall of the southern states, already referred to, no doubt greatly increases erosion. Perhaps equally important is the amount of snowfall, or rather the persistence of snow-cover, since the longer the period during which the ground is covered with snow, the shorter the period of soil erosion.

The snowfall data of the U. S. Weather Bureau are not so arranged as to show readily the period each year for which the ground is covered with snow in any given locality. Recently, however, Brooks published a discussion (1) of the snowfall of the eastern United States in which he reviewed the previous work on the subject and summarized the available data. Brooks also maps the average snowfall for each month, the average annual snowfall in inches, and the average annual number of snowfall days in the eastern United States. From these maps it is possible to get a fairly good idea of the duration of snow-cover in various parts of the region under consideration.

While the total amount of snowfall does not necessarily correspond with duration of snow-cover, in general those regions which have most snow have the longest periods of frozen and snow covered ground, and the shortest periods in which erosion is possible. Certainly soil in the region which has an average of over twenty inches annual snowfall and one inch as early as November is more protected than that south of this region. Longer snow-cover alone would greatly reduce the amount of erosion in the northern states as compared with that in the south. Greater erosion means necessarily more exposed roots and consequently more frequent opportunity for infection with *E. gyrosa*.

CULTURAL CONDITIONS

The contrast between the cultural conditions of the north and south has been frequently noted (4, 9). The relation of cul-

tural conditions to erosion is aptly described by Spillman (9, p. 260) as follows:

> The northern half of the country has always been more or less covered with various grasses. These have prevented soil erosion except in small isolated areas; but in the South where a single-crop system with clean culture has been the rule, and where in consequence, the soils have been left bare during the winter, soil erosion has been an important factor, especially where the land is more or less rolling or hilly.

The effect of the cattle industry in increasing the opportunity for infection and thus in all probability the abundance of the fungus in southern Indiana and Ohio has already been mentioned. And from the beginning of our collecting, the unfenced public squares of the southern towns where stock is permitted to graze have proven most favorable localities for the growth of *Endothia gyrosa*.

In brief, the writer believes that while the occurrence of *E. gyrosa* may be limited by climatic factors which are not yet determined, its prevalence in the southeastern states is caused by the great opportunities for infection in that region, due to the combined influence of host, soil, climatic and cultural conditions.

SUMMARY

Endothia gyrosa, which has a wider known range in America than any other species of the genus, is undoubtedly indigenous, having first been collected by Schweinitz nearly a century ago.

Although found in widely separated localities in the United States it is abundant only in the Southeastern States. Range maps of this and other American species of *Endothia* based on two years' collecting by Dr. C. L. Shear and the writer have already been published.

Inoculation experiments conducted in 1914 and 1915 showed that *E. gyrosa* would under certain conditions grow and winter over beyond the northeastern limits of its known range as well as within the region where it is abundant.

These inoculation experiments emphasized the importance of the water supply and of the condition of the host in the growth of the fungus.

E. gyrosa grows most readily on injured tissue which does not dry out immediately but remains living for some time, such as stubs of cut limbs or injured roots.

The temperature of the Southern States is undoubtedly more favorable for the growth of *E. gyrosa* than that of the states farther north.

The northern boundary of the region where this fungus is abundant does not, however, agree closely with that of any of the temperature regions.

It is not perceptibly more abundant in the areas of nine to twelve months vegetation than it is in areas of seven months vegetation.

Much of the area where *E. gyrosa* is abundant is in or south of the region of 25 inches rainfall, April to September, inclusive. It is, however, very abundant in Tennessee, Kentucky, and Indiana, where the rainfall is less than 25 inches for this period.

Although there are no sudden changes in climate in going from north to south in the eastern United States, there is a fairly definite division into an area where *E. gyrosa* is abundant and an area where it is rare.

This seems to indicate that factors other than climate affect the prevalence of this fungus.

The chief factor in the greater abundance of *E. gyrosa* seems to be increased opportunity for infection.

Opportunity for infection is much greater in the Southern States than in the Northern because of the larger number of host species and their greater importance relative to other species.

Opportunity for infection is still further increased by the soil and cultural conditions which cause greater erosion and leave large numbers of roots of *Fagus* and *Quercus* exposed and subject to injury.

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WASHINGTON, D. C.

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An annotated list of the forest trees of the Hawaiian Archipelago

VAUGHAN MACCAUGHEY

The following material has been prepared as a compact and convenient check list to the Hawaiian arborescent flora. The forests of the Hawaiian Islands are remarkable for the high percentage of endemic forms. Endemism is indicated in the following list by an asterisk (*) before the name. A second symbol (†) indicates that a species was undoubtedly introduced by the aboriginal Hawaiians from the South Pacific and has become naturalized. The data for each species include the scientific name; the Hawaiian and English names if such be possessed by the species; the islands of the group on which the species has been recorded; the vertical range of the species; its general ecologic status, xero-, meso- or hygrophytic; and its usual stature.

It must be noted that many of the Hawaiian species are exceedingly variable, and are not yet thoroughly known from the taxonomic standpoint. Furthermore, this variability also expresses itself in the stature of the plant, which in some instances ranges from a prostate vine to a tree of eighty to one hundred ft. Many of the Hawaiian trees also occur commonly as tall shrubs; in many instances the shrub habit is more prevalent than the arborescent habit. Considerable latitude must also be given in the matter of vertical range, for the islands vary greatly in elevation, as shown by the following figures: NI'I-HAU, 1,300 ft. KAU-A'I, 5,250 ft. OAHU: Ka-ala, 4,030 ft., Kona-hua-nui, 3,105 ft. MOLOKAI: Kama-kou, 4,958 ft., Mauna Loa, 1,382 ft. MAUI: West Maui, 5,788 ft., Hale-a-ka-la, 10,032 ft. LANAI, 3,400 ft. HAWAII: Kohala, 5,489 ft., Mauna Kea, 13,825 ft.; Mauna Loa, 13,675 ft., Hu-ala-lai, 8,269 ft., Kilauea, 4,000 ft. A given species will occupy various altitudes on different islands, and in different mountain ranges, as compatible with its ecologic requirements.

The forest flora of the Hawaiian Islands has been explored by a long series of investigators and collectors, and the present list embodies the results of nearly a century and a half of botanic

research. Some of the important workers have been: Nelson, 1778; Menzies, 1792–4; Chamisso, 1816; botanists of the United States Exploring Expedition, 1840; Seeman, 1848; Remy, 1853; Mann and Brigham, 1864–65; Wawra, 1869; Hillebrand, 1888; Heller, 1896; and Forbes and Rock in recent years.

In the present list the nomenclature of Engler and Prantl is generally followed, and all available data have been incorporated. This is the first time that a comprehensive and concise check list of this character has been prepared, covering the Hawaiian forest trees.

CYATHEACAE

*1. Cibotium Menziesii Hook. *Hapu i'i'i* or *Hei'i;* Greater Tree-Fern; all islands; 2,000–6,500 ft.; hydrophytic; 25–40 ft.; trunks fibrous and spongy, used for corduroy roads, etc.

*2. Cibotium Chamissoi Kaulf. *Hapu;* Lesser Tree-Fern; all islands; 1,500–6,500 ft.; hydro- and mesophytic; 12–25 ft.; trunk as in the preceding.

*3. Cibotium glaucum Hook. & Arn. Glaucous Tree-Fern; *Hapu;* all islands, rare; elevation and ecology as for *C. Chamissoi;* 10–20 ft.

PANDANACEAE

†4. Pandanus odoratissimus L. *Hala* or *Lau-Hala;* Pandanus, Screw-Pine; all islands; sea-level to 2,000 ft.; mesophytic; 15–25 ft.; leaves and fruit used by natives; widely distributed throughout the Old World tropics, the islands of the Pacific, and most abundant in Malaysia.

PALMAE

*5. Pritchardia. *Loulu;* Hawaiian Fan Palm; all islands, including Nihoa and Laysan; sea-level to 4,500 ft.; hygrophytic, rarely semi-xerophytic; 8–40 ft.; there are at least two well defined species, *P. Gaudichaudii* H. Wendl., and *P. Martii* H. Wendl.; there are a number of other forms, some of which will probably merit specific status when the genus has been fully investigated.

†6. Cocos nucifera L. Coconut Palm; *Niu;* all islands; littoral and lower valleys; 40–100 ft.; mesophytic; this is the northern limit of the coconut palm in the Pacific; it occurs in many tropical regions and islands, particularly in tropical America and the Pacific.

LILIACEAE

*7. Dracaena aurea Mann. *Hala-pepe;* all islands; 1,000–2,000 ft.; xerophytic: 20–40 ft.; wood very soft and white.

ULMACEAE

8. Trema amboinensis (Willd.) Blume. Oahu and Molokai only; 1,000–3,000 ft.; mesophytic; 20–30 ft.; very rare; abundant on many of the islands of the Pacific, particularly in the South Pacific.

MORACEAE

9. Pseudomorus Brunoniana (Endl.) Bureau. *Ai-ai;* Hawaiian False Mulberry; all islands; 1,000–3,000 ft.; xerophytic; 20–40 ft.; wood hard and durable, like

oak; occurs also in the Australasian region and was first found on Norfolk Island.

†10. Artocarpus incisa (Thunb.) Forst. *Ulu;* Bread-Fruit; all islands, lowlands and valleys, never wild; mesophytic; 30–60 ft.; meso- to hygrophytic; seedless; widely cultivated in the tropical regions of the Old World, particularly in tropical Asia and Polynesia.

URTICACEAE

*11. Urera sandvicensis Wedd. *O-puhe;* all islands; 800–5,000 ft.; meso- to hygrophytic; 10–25 ft., often shrubby; a valuable fiber plant in former times.

12. Pipturus albidus (Hook. & Arn.) Gray. *Ma-make;* all islands; 1,000–4,000 ft.; meso- to hygrophytic; 8–30 ft., usually small and shrubby; another valuable fiber plant in native days; reported also from Tahiti.

SANTALACEAE

*13. Santalum Freycinetianum Gaud. *Ili-ahi;* Hawaiian Sandalwood; all islands; sea-level to 6,000 ft.; xero- to mesophytic, usually the former; highly variable, 6–50 ft.; this and the following species furnished the Hawaiian sandalwood of commerce.

*14. Santalum ellipticum Gaud. *Ili-ahi;* Kauai and Oahu only; 600–1,800 ft.; mesophytic; 18–30 ft.

*15. Santalum pyrularium Gray. *Ili-ahi;* Kauai only; 3,000–4,000 ft.; meso- and hygrophytic; 35–40 ft.

*16. Santalum haleakalae Hillebd. *Ili-ahi;* Mount Hale-a-ka-la, Maui, only; 7,000–10,000 ft.; xerophytic; 15–25 ft.

AMARANTACEAE

*17. Charpentiera obovata Gaud. *Pa-pala;* all islands; 1,000–4,000 ft.; meso- and hygrophytic; 15–35 ft.

*18. Nototrichium sandwicense (Gray) Hillebd.; *Ku-lui;* all islands; 1,000–3,000 ft.; xerophytic; 8–20 ft.

NYCTAGINACEAE

*19. Pisonia umbellifera (Forst.) Seem. *Pa-pala ke-pau;* all islands; 200–2,000 ft.; hygrophytic; 15–30 ft.; wood soft and spongy.

*20. Pisonia sandwicensis Hillebd. *Pa-pala ke-pau* or *Aulu;* all islands; 1,500–3,000 ft.; xerophytic; 40–60 ft.

21. Pisonia inermis Forst. *Pa-pala ke-pau;* Molokai to Hawaii; 2,000–4,500 ft.; xerophytic; 15–18 ft.; occurs in India, Malaysia, and the islands of the South Pacific.

LAURACEAE

*22. Cryptocarya Mannii Hillebd. *Holio;* Kauai and Waianae Range of Oahu only; 2,500–4,000 ft.; meso- to xerophytic, intolerant; 18–30 ft.

SAXIFRAGACEAE

*23. Broussaisia arguta Gaud. *Kana-awu* and *Pua-ha-hui;* all islands; 1,000–3,500 ft.; hygrophytic; 6–15 ft., often shrubby.

*24. Broussaisia pellucida Gaud. *Pua-ha-nui;* all islands; 2,500–6,000 ft.; hygrophytic, 6–15 ft., often shrubby.

PITTOSPORACEAE

*25. Pittosporum glabrum Hook. & Arn. *Ho-awa;* Oahu only; 1,800–2,500 ft.; meso- and hygrophytic; 15–20 ft.

*26. Pittosporum acuminatum Mann. *Ho-awa* or *Papa-he-kili;* Kauai only; 2,000–4,000 ft.; mesophytic to semi-hygrophytic; 15–20 ft.

*27. Pittosporum spathulatum (Gray) Mann. *Ho-awa;* Oahu only; 2,000–4,000 ft.; hygrophytic; 15–20

*28. Pittosporum glomeratum Hillebd. *Ho-awa;* Oahu only; 1,500–2,500 ft.; hygrophytic; 10–15 ft.

*29. Pittosporum terminalioides Planch. *Ho-awa;* Maui, Lanai, Hawaii; 1,000–7,000 ft.; xerophytic; 15–20 ft.

*30. Pittosporum cauliflorum Mann. *Ho-awa;* Kauai and Waianae Range of Oahu only; 1,000–4,000 ft.; hygrophytic; 20–30 ft.

*31. Pittosporum Hosmeri Rock. *A-awa hua kukui;* Hawaii only; 2,000–5,000 ft.; xero- and mesophytic; 15–25 ft.

*32. Pittosporum Gayanum Rock. *Ho-awa;* Kauai only; 4,800–5,000 ft.; hygrophytic; 15–18 ft.

*33. Pittosporum insigne Hillebd. *Ho-awa;* Maui only; 2,000–6,000 ft.; hygro; phytic; 18–25 ft.

*34. Pittosporum hawaiiense Hillebd. *Ho-awa;* Hawaii only; 2,200–4,000 ft.; hygrophytic; 15–18 ft.

*35. Pittosporum kauaiense Hillebd. *Ho-awa;* Kauai only; 2,000–4,000 ft.; hygrophytic; 30–40 ft., the largest member of the genus.

*36. Pittosporum confertiflorum Gray. *Ho-awa;* Maui, Lanai, Hawaii; 2,000–5,000 ft.; hygrophytic; 15–22 ft.

LEGUMINOSAE

*37. Acacia koa Gray. *Koa;* all islands, a dominant species, formerly exceedingly plentiful; sea-level to 6,000 ft.; mesophytic to semi-xerophytic, also growing in lower rain-forests; 20–80 ft.; wood valuable, the "Hawaiian Mahogany" of commerce; used for furniture, interior trim, etc.

*38. Acacia koaia Hillebd. *Koa-ia* or *Koa-oha;* Molokai, Maui, Hawaii; 1,000–3,000 ft.; xerophytic; 20–25 ft.; wood much harder than *koa;* tree not abundant.

*39. Mezoneurum kauaiense (Mann) Hillebd. *Uhi-uhi* or *Kea;* all islands except Molokai and Lanai; 500–3,000 ft.; xerophytic; 20–30 ft.; wood extremely hard, almost black.

*40. Sophora chrysophylla (Salisb.) Seem. *Ma-mani;* all islands except Oahu and Molokai; sea-level to 10,000 ft., most abundant in upper forest zone of Hawaii; xerophytic; 4–40 ft., the largest trees occurring at the higher levels; wood very hard and durable, much used for posts.

41. Erythrina monosperma Gaud. *Wili-wili;* all islands; lowlands up to 1,500 ft.; strongly xerophytic; 20–30 ft.; deciduous; wood very white and buoyant, soft and like cork; occurs in various island groups of the South Pacific Ocean.

RUTACEAE

*42. Xanthoxylum oahuense Hillebd. *Ae* or *He-a'e;* Oahu only; 1,800–3,000 ft.; hygrophytic; 15–20 ft.

*43. Xanthoxylum hawaiiense Hillebd. *A'e* or *He-a'e;* Hawaii and Mount Hale-a-ka-la, Maui; var. *citriodora* Rock occurs on Lanai and Kauai; 1,200–6,000 ft.; xerophytic; 15–25 ft.

*44. Xanthoxylum glandulosum Hillebd. *A'e* or *He-a'e;* Maui and Hawaii; 1,000–3,000 ft.; hygrophytic; 10–15 ft.; rare.

*45. Xanthoxylum kauaiense Gray. *A'e* or *He-a'e;* Kauai, Maui, Hawaii; 1,500–4,000 ft.; meso- and xerophytic; 20–40 ft.

*46. Xanthoxylum mauiense Mann. *A'e* or *He-a'e;* all islands; 1,000–4,000 ft.; xerophytic or semi-mesophytic; 10–18 ft.; highly variable.

*47. Xanthoxylum dipetalum Mann. *A'e* or *He-a'e;* Kauai, Oahu, Hawaii; 1,000–4,000 ft.; mesophytic; 20–40 ft.

*48. Pelea clusiaefolia Gray. *Alani;* all islands; 1,000–4,000 ft.; hygrophytic; 20–30 ft.

*49. Pelea sapotaefolia Mann. *Alani;* Kauai only; 3,000–5,200 ft.; hygrophytic; 15–20 ft.

*50. Pelea waialealae Wawra. *Ano-nia* or *Alani-wai;* Kauai only; 3,000–5,200 ft.; hygrophytic; 3–20 ft.; often shrubby.

*51. Pelea auriculaefolia Gray. *Alani;* Hawaii only; 4,000–5,000 ft.; hygrophytic; 8–15 ft.; often shrubby.

*52. Pelea microcarpa Heller. *Ku-kai-moa;* Kauai only; 3,500–4,000 ft.; hygrophytic; 10–15 ft.

*53. Pelea volcanica Gray. *Alani;* Maui, Lanai, Hawaii; 2,500–6,000 ft.; hygrophytic; 25–40 ft.; quite variable.

*54. Pelea sandwicensis (Gaud.) Gray. *Alani;* Oahu only; several doubtful varieties from Kauai, Molokai, and Maui; 1,600–2,500 ft.; hygrophytic; 20–30 ft.

*55. Pelea orbicularis Hillebd. *Alani;* Kauai and West Maui only; 4,000–5,700 ft.; strongly hygrophytic; 8–10 ft.

*56. Pelea kauaiensis Mann. *Pilo-ula;* Kauai only; 4,000–5,000 ft.; strongly hygrophytic; 10–16 ft.

*57. Pelea rotundifolia Gray. *Alani;* Oahu, Ko'o-lau Range only; 1,800–2,500 ft.; hygrophytic; 10–18 ft.; often shrubby.

*58. Pelea molokaiensis Hillebd. *Alani;* Oahu, Molokai, and West Maui, most abundant on Molokai; 1,000–4,000 ft.; hygrophytic; 15–20 ft.

*59. Pelea macropus Hillebd. *Alani;* Kauai only; a variety occurs in the Kohala Mountains of Hawaii; 3,000–4,000 ft.; hygrophytic; 12–18 ft.

*60. Pelea anisata Mann. *Moki-hana;* Kauai only; 3,000–4,000 ft.; hygrophytic; 18–24 ft.; all parts very fragrant.

*61. Pelea Wawraeana Rock. *Alani;* Oahu only; 2,000–3,000 ft.; hygrophytic; 10–15 ft.

*62. Pelea multiflora Rock. *Alani;* Maui, leeward slopes of Hale-a-ka-la, only; 2,600–3,000 ft.; xerophytic; 30–40 ft.

*63. Pelea Knudsenii Hillebd. *Alani;* Kauai only; 1,500 ft.; xerophytic; 25–30 ft.

*64. Pelea barbigera (Gray) Hillebd.; *Alani;* Kauai only; 3,600–4,000 ft.; hygro- or mesophytic; 10–15 ft.; often shrubby.

*65. Pelea elliptica (Gray) Hillebd. *Alani;* Oahu, Molokai, and Maui; 1,000–3,500 ft.; 10–15 ft.; often shrubby.

*66. Pelea cinerea (Gray) Hillebd. *Alani* or *Ma-nena;* Oahu, Maui, Lanai, and Hawaii; 1,500–4,000 ft.; xerophytic; 10–35 ft.

*67. Platydesma campanulatum Mann. *Pilo kea;* all islands except Molokai and Lanai; 1,500–4,000 ft.; hygrophytic; 6–20 ft.; very variable, and often shrubby.

EUPHORBIACEAE

*68. Neowawraea phyllanthoides Rock.; Hawaii only; 2,000 ft.; xerophytic; 30–35 ft.; excessively rare; wood black, heavy.

*69. Antidesma platyphyllum Mann. *Hame* or *Ha'a;* all islands; 1,500–3,000 ft.; hygro- and mesophytic; 20–30 ft.

*70. Antidesma pulvinatum Hillebd.; *Me-hame* or *Ha'a;* all islands; 1,000–3,000 ft.; strongly xerophytic; 15–20 ft.

*71. Claoxylon sandwicense Mull.-Arg.; *Po-ola;* all islands; 1,000–2,500 ft.; xerophytic; 15–20 ft.

†72. Aleurites moluccana (L.) Willd. *Kukui;* abundant on all the islands; a dominant species in the lower forest zone, sea-level to 2,200 ft.; meso- and hygrophytic; 30–80 ft.; this is the Candle-nut or Wood-Oil tree of the South Pacific; abundant in Malaysia and the islands of the South Pacific Ocean.

*73. Euphorbia lorifolia (Gray) Hillebd.; *Koko* or *A-koko;* Molokai to Hawaii; 1,000–3,000 ft.; strongly xerophytic; 10–25 ft.; one variety is very laticiferous.

*74. Euphorbia Rockii Forbes. Oahu only; 2,000–2,500 ft.; hygrophytic; 15–20 ft., often shrubby.

ANACARDIACEAE

75. Rhus semialata sandwicensis (Gray) Engler. *Nene-leau* or *Ne-leau;* Hawaiian Sumach; all islands; 600–2,000 ft.; mesophytic; 15–25 ft.; stoloniferous, forming clumps; the range of the typical form of *R. semialata* Murr. extends from the Himalayas to China and Japan.

AQUIFOLIACEAE

*76. Ilex sandwicensis (Endl.) Loes. *Ka-wau* or *Ai-ea;* all islands; 2,000–5,000 ft.; hygrophytic; 15–40 ft.

CELASTRACEAE

*77. Perrottetia sandwicensis Gray. *Olo-mea* or *Wai-mea;* all islands; 1,000–6,000 ft.; hygro- to xerophytic; 10–20 ft., often shrubby.

SAPINDACEAE

78. Sapindus Saponaria L. *A'e* or *Ma-nele;* Maui and Hawaii; 3,000–4,500 ft.; mesophytic; 50–80 ft.; deciduous; indigenous to tropical America, but occurring on various island groups of the Pacific.

*79. Sapindus oahuensis Hillebd.; *Aulu, Ka-ulu,* or *Lono-mea;* Kauai and Oahu only; 700–1,500 ft.; mesophytic, 20–30 ft.

*80. Alectryon macrococcus Radlk.; *Ma-hoe;* all islands, but very rare; 1,000–3,000 ft.; xerophytic; 20–25 ft.

81. Dodonaea viscosa L. *A'ali'i* or *A'a-li'i ku-ma-kua;* all islands; 800–9,000 ft.; hygro- to xerophytic; 15–25 ft.; a cosmopolitan species, occurring in tropical and subtropical regions throughout the world.

*82. Dodonaea eriocarpa Smith. *A'a-li'i ku-ma-kua;* Kauai, Maui, Hawaii, 2,000–8,000 ft.; xerophytic; 8–20 ft.; often shrubby.

RHAMNACEAE

*83. Colubrina oppositifolia Brongn. *Kau-ila;* Hawaii only; 2,000 ft.; meso- to xerophytic; 25–40 ft.; wood very hard; red.

84. Alphitonia excelsa (Fenzl) Reiss. *Kau-ila* or *O'a;* all islands; 2,000–3,000 ft.; xerophytic, sometimes mesophytic; 40–80 ft.; wood very hard and heavy, red

with black streaks; a highly variable species, occurring in Malaysia, Australasia, and other islands of the Pacific.

ELAEOCARPACEAE

*85. Elaeocarpus bifidus Hook. & Arn. *Kalia;* Kauai and Oahu only; 2,000–4,000 ft.; strongly hygrophytic; 20–40 ft.

MALVACEAE

†86. Hibiscus tiliaceus L. *Hau;* all islands; abundant littoral and lowland tree; mesophytic; 20–30 ft.; forming extensive horizontal jungles by decumbent rooting branches; a cosmopolitan species, occurring in warm countries throughout the world.

*87. Hibiscus Arnottianus Gray; *Kokia keo-keo;* all islands; 1,000–2,500 ft.; hygrophytic; 15–30 ft.; beautiful white flowers.

*88. Hibiscus waimeae Heller. *Kokia keo-keo;* Kauai White Hibiscus; Kauai only; 2,000–3,000 ft.; hygrophytic; 20–30 ft.; showy white flowers.

*89. Hibiscus kokio Hillebd. *Kokia ula* or *Pu-alo-alo;* Native Red Hibiscus; all islands; rare; 300–2,000 ft.; hygrophytic; 8–40 ft., often shrubby; flowers rich red.

*90. Hibiscadelphus Giffardianus Rock, H. Wilderianus Rock, and H. hualalaiensis Rock. *Hau kuahiwi;* Hale-a-ka-la and Hawaii, excessively rare, only one or a few trees of each species, practically extinct, and of no economic value; 3,000–4,200 ft.; xerophytic; 15–20 ft.

†91. Thespesia populnea (L.) Corr. *Milo;* common littoral tree on all the islands; mesophytic; 30–40 ft.; a fine cabinet-wood; a cosmopolitan littoral species, occurring in tropical Africa, Asia, and Oceanica.

*92. Kokia Rockii Lewton. *Kokio;* Native Red Cotton Tree; Hawaii only, exceedingly rare; 2,000 ft.; xerophytic; 12–15 ft. *K. drynarioides* (Seem.) Lewton has now become extinct in the wild state; for many years it had been excessively rare.

THEACEAE

*93. Eurya sandwicensis Gray. *A-nini* or *Wa-nini;* all islands; 1,500–6,000 ft.; hygrophytic; 15–20 ft., often shrubby.

GUTTIFERAE

†94. Calophyllum inophyllum L. *Ka-mani;* a common littoral tree on all the islands, also in the lowlands; mesophytic; 50–60 ft., valued for its wood and oil; abundant in tropical Asia, Malaysia, and islands of the South Pacific.

FLACOURTIACEAE

*95. Xylosma hawaiiense Seem. *Ma-ua;* Kauai and Oahu only; 1,500–3,000 ft. meso- or semi-xerophytic; sometimes hygrophytic; 15–30 ft.

*96. Xylosma Hillebrandii Wawra; *Ma-ua;* all islands except Kauai and Oahu; 1,000–4,500 ft.; xerophytic; 10–15 ft.

THYMELAEACEAE

*97. Wikstroemia oahuensis (Gray) Rock. *Akia;* Oahu only; 600–3,000 ft.; hygrophytic; 2–15 ft., small shrub at lower levels, arborescent at the higher levels.

*98. Wikstroemia sandwicensis Meisn. *Akia;* Hawaii only; 3,000–5,000 ft.; meso- to xerophytic; 6–15 ft. often shrubby.

*99. Wikstroemia furcata (Hillebd.) Rock. *Akia;* Kauai only; 3,500–4,500 ft.; strongly hygrophytic; 12–15 ft. often shrubby.

MYRTACEAE

†100. Eugenia malaccensis L. *Ohia ai;* Mountain Apple Tree; all islands, abundant in valley floors, up to 2,000 ft.; strongly hygrophytic; 30–60 ft.; fruit juicy and edible; a cosmopolitan species, occurring in many of the island groups of the South Pacific and in tropical Asia.

*101. Eugenia sandwicense Gray. *Ohia ha* or *Pa-ihi;* all islands; 1,500–4,000 ft.; hygrophytic; 40–60 ft.

*102. Metrosideros polymorpha Gaud. *Le-hua* or *Ohia le-hua;* sea-level to 9,000 ft., in all habitats and situations; from excessively xerophytic to excessively hygrophytic; stature highly variable, from a prostrate vine to a tree of 100 ft., usually a tree of 20–50 ft.; the most abundant tree on the islands, and exceeding the *koa* in timber value; wood lumbered and used for many purposes; abundant in New Zealand and Polynesia.

*103. Metrosideros tremuloides (Heller) Rck. *Le-hua a-hi-hi;* Kauai and Oahu; 1,000–5,200 ft.; strongly hygrophytic; 10–25 ft., often shrubby.

*104. Metrosideros rugosa Gray. *Le-hua papa;* Oahu only; 2,000–4,000 ft.; hygrophytic, on exposed summit ridges; 10–15 ft., often shrubby.

*105. Metrosideros macropus Hook. & Arn. *Ohia lehua;* Kauai, Oahu, and Molokai; 1,500–3,000 ft.; hygrophytic; 30–40 ft.

ARALIACEAE

*106. Tetraplasandra hawaiiensis Gray. *Ohe;* all islands; 2,000–4,000 ft.; meso- and hygrophytic; 40–80 ft.

*107. Tetraplasandra waimeae Wawra. *Ohe ki-ko-ola;* Kauai only; 3,200–4,000 ft.; meso- and hygrophytic; 30–40 ft.

*108. Tetraplasandra waialealae Rock. Kauai only, in summit bogs; 5,000 ft.; strongly hygrophytic; 15–25 ft.

*109. Tetraplasandra lanaiensis Rock. Lanai only; 2,000 ft.; mesophytic; 20 ft.

*110. Tetraplasandra Lydgatei (Hillebd.) Harms. Oahu only; 1,500–2,000 ft.; hygrophytic; 10–20 ft.

*111. Tetraplasandra oahuensis (Gray) Harms. Oahu only; *Ohe mauka;* 1,000–3,000 ft.; hygrophytic; 15–20 ft.

*112. Tetraplasandra kaalae (Hillebd.) Harms. *Ohe;* Oahu only, Waianae Range; 3,000–4,000 ft.; strongly hygrophytic; 12–16 ft.

*113. Tetraplasandra meiandra (Hillebd.) Harms. *Ohe;* all islands; 1,000–4,000 ft.; xero- to hygrophytic; 20–50 ft., attaining greatest stature in arid regions.

*114. Reynoldsia sandwicensis Gray; *Ohe* or *Ohe makai;* all islands; lowlands to 1,500 ft.; xerophytic; 15–60 ft.; deciduous.

*115. Pterotropia gymnocarpa Hillebd. *Ohe-ohe;* Oahu only; 1,500–2,500 ft.; strongly hygrophytic; 15–30 ft.

*116. Pterotropia kavaiensis (Mann) Hillebd. *Ohe-ohe;* Kauai only; 2,500–4,000 ft.; meso- to hygrophytic; 40–60 ft.

*117. Pterotropia dipyrena (Mann) Hillebd. *Ohe-ohe;* Maui, Lanai and Hawaii; 2,000–4,500 ft.; xero- to hygrophytic; 20–60 ft.

*118. Cheirodendron Gaudichaudii (DC.) Seem. *Olapa;* all islands; 2,000–4,000 ft.; hygrophytic; 30–50 ft.

*119. Cheirodendron platyphyllum (Hook. & Arn.) Seem. *Lapa-lapa;* Kauai and Oahu only; 3,000–5,000 ft.; strongly hygrophytic.

EPACRIDACEAE

120. Styphelia tameiameia (Cham.) F. Muell. *Pu-keawe* or *Pua-keawe;* all islands; 1,000–10,000 ft.; all habitats, from xero- to hygrophytic; shrubby at the lower, arborescent (10–18 ft.) at the higher levels; known also from Tahiti and Eimeo of the Society Group.

MYRSINACEAE

*121. Suttonia kauaiensis (Hillebd.) Mez. *Ko-lea;* Kauai only; 2,000 ft.; 25–35 ft.,; hygrophytic.

*122. Suttonia Wawraea Mez. *Ko-lea;* Kauai only; 3,000–4,500 ft.; strongly hygrophytic; 10–15 ft., often shrubby.

*123. Suttonia lanaiensis (Hillebd.) Mez. Lanai and Maui only; 1,000–2,500 ft.; meso- to xerophytic; 20–30 ft.

*124. Suttonia Fernseei Mez. Kauai only; 3,000 ft.; hygrophytic; size unknown; very rare.

*125. Suttonia spathulata Rock. *Ko-lea;* Maui only; 6,500 ft.; xerophytic; 15 20 ft.

*126. Suttonia volcanica Rock. *Ko-lea;* Maui and Hawaii only; 2,000–5,500 ft.; strongly xerophytic; 12–20 ft.

*126. Suttonia Knudsenii Rock. *Kolea;* Kauai only; 3,000–4,000 ft.; strongly hygrophytic; 15 ft., often shrubby.

*127. Suttonia Hillebrandii Mez. *Ko-lea;* Kauai and Oahu only; 2,500–4,000 ft.; hygrophytic; 15–20 ft.

*128. Suttonia Lessertiana (A.DC.) Mez. *Ko-lea;* all islands; 1,500–5,500 ft.; hygrophytic; 20–60 ft.; very variable.

*129. Suttonia sandwicensis (A.DC.) Mez; *Ko-lea lau-lii;* all islands; 3,000–6,000 ft.; hygrophytic; 15–25 ft., often shrubby.

*130. Suttonia lanceolata (Wawra) Rock. Kauai only; 4,000–5,200 ft.; strongly hygrophytic, summit bogs only; 8–15 ft., often shrubby.

SAPOTACEAE

*131. Chrysophyllum polynesicum (Benth. & Hook.) Hillebd. *Ke-ahi;* all islands except Hawaii; 1,000–3,000 ft.; strongly xerophytic; 20–35 ft.

*132. Sideroxylon sandwicense (Gray) Benth. & Hook. *Ala'a or Ka-ulu;* all islands except Hawaii; 1,000–4,000 ft.; xero- to hygrophytic, chiefly the former; 30–50 ft.

*133. Sideroxylon Ceresolii Rock. Maui only; 3,000 ft.; hygrophytic; 20–30 ft.; rare.

*134. Sideroxylon rhynchospermum Rock. *Ala'a;* Maui only; 1,300 ft.; hygrophytic; 30–35 ft.; scarce.

*135. Sideroxylon auahiense Rock. *Ala'a;* Maui and Hawaii only; 3,000 ft.; xerophytic; 25–40 ft.

*136. Sideroxylon spathulatum Hillebd. *Ala'a;* Oahu, Molokai, Lanai; 1,000–3,000 ft.; mesophytic; 12–18 ft., often shrubby.

EBENACEAE

*137. Maba sandwicensis A.DC. *Lama;* Hawaiian Ebony; all islands; 1,000–3,000 ft.; xero- to hygrophytic, chiefly the former; 30–40 ft.; wood very hard, rich brown color.

*138. Maba Hillebrandii Seem. *Lama;* Oahu only; 1,500–2,500 ft.; hygrophytic; 20–30 ft.

OLEACEAE

*139. Osmanthus sandwicensis (Gray) Knobl. *Pua* or *Olo-pua;* Hawaiian Olive; all islands; 600–4,000 ft.; xero- to mesophytic, chiefly the former; 30–60 ft.; wood very hard.

LOGANIACEAE

*140. Labordia molokaiana Baillon. *Ka-maka-hala;* Molokai; 3,000 ft.; strongly hygrophytic; 30 ft.

*141. Labordia membranacea Mann. *Ka-maka-hala;* Oahu only; 1,500–2,500 ft.; hygrophytic; 10–20 ft.

*142. Labordia sessilis Gray. *Ka-maka-hala;* Oahu only; 1,000–3,000 ft.; strongly hygrophytic; 10–35 ft., often shrubby.

*143. Labordia tinifolia Gray. *Ka-maka-hala;* Kauai to Maui; 1,000–3,000 ft.; meso- to xerophytic; 15–20 ft., often shrubby.

APOCYNACEAE

*144. Pteralyxia macrocarpa (Hillebd.) Schum. *Ka-ulu;* Oahu only; hygrophytic; 1,000–3,000 ft.; rare; 15–25 ft.

*145. Rauwolfia sandwicensis A.DC. *Hao;* all islands; 1,500–2,500 ft.; meso- to hygrophytic, sometimes xerophytic; 15–20 ft., often shrubby.

*146. Ochrosia sandwicensis Gray. *Ho-lei;* all islands; 1,000–4,000 ft.; xero- to mesophytic; 10–25 ft., often shrubby.

BORRAGINACEAE

†147. Cordia subcordata Lam. *Kou;* all islands, formerly an abundant littoral tree; now very rare; mesophytic; 15–50 ft.; wood with beautiful grain, formerly prized by the natives; occurs in the Indian and South Pacific Oceans and throughout Polynesia.

SOLANACEAE

*148. Nothocestrum longifolium Gray. *Ai-ea;* all islands; 1,000–5,000 ft.; hygrophytic; 10–20 ft., often shrubby.

*149. Nothocestrum breviflorum Gray. *Ai-ea;* Hawaii only; 2,000–2,800 ft.; xerophytic; 30–35 ft.; wood very soft.

*150. Nothocestrum latifolium Gray. *Ai-ea;* all islands except Hawaii; 1,500–3,000 ft.; xerophytic; 20–30 ft.

*151. Nothocestrum subcordatum Mann. *Ai-ea;* Kauai and Oahu only; 1,500–3,500 ft.; meso- to hygrophytic; 25–35 ft.

*152. Solanum Carterianum Rck. *Pua-nana-ho-nua;* Oahu only; 1,500 ft.; hygrophytic; 15–20 ft.; exceedingly rare (one tree).

MYOPORACEAE

*153. Myoporum sandwicense (ADC.) Gray. *Naio;* Bastard Sandalwood; all islands; a very plentiful forest tree, from sea-level to 10,000 ft.; xero- to hygrophytic, chiefly the former; stature very variable, from a shrub of 2–3 ft. up to a tree of 50–65 ft.; wood fragrant, like *Santalum*.

RUBIACEAE

*154. Gouldia axillaris Wawra. *Ma-nono;* all islands; 2,500–3,500 ft.; hygrophytic; 20–25 ft.; variable.

*155. Gouldia elongata Heller. *Ma-nono;* Kauai; 2,000 ft.; hygrophytic; 10–20 ft., often shrubby.

*156. Gouldia macrocarpa Hillebd. *Ma-nono;* Kauai and Oahu only; 2,000–4,000 ft.; hygrophytic; 10–20 ft.

*157. Gardenia Brighami Mann. *Na'u;* all islands; 1,000–3,000 ft.; xerophytic; 10–18 ft., often shrubby; flowers fragrant.

*158. Gardenia Remyi Mann. *Na'u;* all islands; 1,000–4,000 ft.; hygrophytic; 20–40 ft.; flowers white, fragrant.

159. Plectronia odorata (Forst.) F. Müll. *Ala-hee* or *Wala-hee;* all islands; 600–2,200 ft., abundant; xero- to mesophytic; 6–20 ft., often shrubby.

*160. Bobea elatior Gaud. *Aha-kea;* Kauai, Oahu, Molokai, Hawaii; 1,000–4,000 ft.; hygrophytic; 25–40 ft.; wood yellow.

*161. Bobea Hookeri Hillebd.; *Aha-kea;* Oahu, Molokai, Maui, very rare; 1,000–3,000 ft.; 25–35 ft.; hygrophytic.

*162. Bobea sandwicensis (Gray) Hillebd. *Aha-kea;* West Maui, Molokai, Lanai; 1,000–2,000 ft.; 15–25 ft., often shrubby.

*163. Bobea timonioides (Hook. f.) Hillebd. *Aha-kea;* Hawaii only; xerophytic; 800–2,000 ft.; size unknown; very rare.

*164. Bobea Mannii Hillebd.; *Aha-kea;* Kauai only; 2,000–3,000 ft.; hygro- to mesophytic; 20–30 ft.

*165. Straussia kaduana (Cham. & Schlecht.) Gray. *Ko-piko kea;* Oahu, Molokai, Lanai; common, variable; 1,000–3,000 ft.; hygrophytic; 10–20 ft., often shrubby.

*166. Straussia longissima Rock. *Ko-piko;* Oahu only; 1,000 ft.; hygrophytic; 12–20 ft.; rare.

*167. Straussia onocarpa Hillebd.; *Ko-piko;* Kauai, Maui, Lanai; 1,000–3,000 ft.; hygrophytic; 25–50 ft.; varieties occur on Molokai and Hawaii.

*168. Straussia Fauriei Lévl. *Ko-piko;* Oahu and Lanai; 2,000–3,000 ft.; hygrophytic; 10–15 ft.

*169. Straussia leptocarpa Hillebd.; *Ko-piko;* Maui only; 2,000–3,000 ft.; xero- to mesophytic; 15–20 ft.

*170. Straussia Mariniana (Cham. & Schlecht.) Gray; *Ko-piko;* Kauai, Oahu Maui; 2,500–3,500 ft.; hygrophytic; 10–20 ft.

*171. Straussia hawaiiensis Gray. Hawaii only; *Ko-piko;* 2,000–4,000 ft.; meso- to hygrophytic; 20–35 ft.

*172. Straussia Hillebrandii Rock. *Ko-piko;* Hawaii and Molokai; 2,000–4,000 ft.; hygrophytic; 15–20 ft.

*173. Psychotria hexandra Mann. Kauai and Oahu; 1,000–3,000 ft.; hygrophytic; 15–20 ft.

*174. Psycotria grandiflora Mann. Kauai only; 2,000–3,000 ft.; hygrophytic; 15–20 ft., often shrubby.

*175. Psychotria hirta (Wawra) Heller; Kauai only; 2,000–3,000 ft.; hygrophytic; 10–20 ft., often shrubby.

*176. Coprosma montana Hillebd. *Pilo;* Kauai, Maui, and Hawaii; 4,000–10,000 ft.; xero- to hygrophytic; 3–20 ft., variable, often shrubby, sometimes prostrate.

*177. Coprosma rhyncocarpa Gray; *Pilo;* Hawaii only; 3,000–6,000 ft.; meso- to hygrophytic; 15–20 ft., often shrubby.

*178. Coprosma Vontempskyi Rock. *Pilo;* Maui only; 4,000 ft.; hygrophytic; 15–20 ft.; precinctive.

*179. Coprosma Grayana Rock. *Pilo;* Hawaii only; 3,000 ft.; hygrophytic; 20–25 ft.; precinctive.

*180. Coprosma pubens Gray. *Pilo;* all islands; 2,000–5,000 ft.; hygrophytic; 10–20 ft., often shrubby.

*181. Coprosma kauaiensis (Gray) Heller. *Koi;* Kauai only; 2,000–3,000 ft.; hygrophytic; 15–20 ft., often shrubby.

*182. Coprosma waimeae Wawra. *Olena;* Kauai only; 3,500–4,000 ft.; hygrophytic; 15–20 ft.

*183. Coprosma longifolia Gray. *Pilo;* Kaui, Oahu, Lanai, Hawaii; 1,000–4,000 ft.; hygrophytic; 15–20 ft., often shrubby.

†184. Morinda citrifolia L. *Noni;* all islands, lowlands, around native settlements; meso- to xerophytic; 15–25 ft.; occurring also in Asia and Australia.

*185. Morinda trimera Hillebd. *Noni kua-hiwa;* Oahu, Maui, very rare; 2,000–4,000 ft.; hygrophytic; 15–30 ft.

CAMPANULACEAE

*187. Clermontia grandiflora Gaud. Molokai, Maui, Lanai; 2,000–5,000 ft.; hygrophytic; 6–18 ft., often shrubby.

*188. Clermontia drepanomorpha Rock. Hawaii only; 4,000–5,000 ft.; strongly hygrophytic; 12–20 ft.

*189. Clermontia persicaefolia Gaud. Oahu only; 1,000–4,000 ft.; hygrophytic; 12–18 ft., often shrubby.

*190. Clermontia oblongifolia Gaud. Oahu, Molokai, Maui; 1,000–4,000 ft.; hygrophytic; 15–25 ft., often shrubby.

*191. Clermontia kohalae Rock. Hawaii only; 1,500–2,500 ft.; hygrophytic; 15–18 ft.

*192. Clermontia leptoclada Rock. Hawaii only; 4,000–4,500 ft.; strongly hygrophytic; 18–20 ft.

*193. Clermontia hawaiiensis (Hillebd.) Rock. Hawaii only; 3,000–5,000 ft.; hygrophytic; 15–25 ft., often shrubby.

*194. Clermontia Gaudichaudii (Gaud.) Hillebd. *Ha-ha;* Kauai only; 3,500–4,500 ft.; strongly hygrophytic; 15–25 ft., often shrubby.

*195. Clermontia Peleana Rck. Hawaii only, very rare; 3,800 ft.; hygrophytic; 20 ft.; precinctive.

*196. Clermontia arborescens (Mann) Hillebd. Molokai, Maui, Lanai; 2,000–4,500 ft.; hygrophytic; 15–25 ft.

*197. Clermontia tuberculata Forbes. Maui only; 5,000 ft.; hygrophytic; 12–15 ft.; very rare, precinctive.

*198. Clermontia coerulea Hillebd. Hawaii only; 1,800–4,500 ft.; hygrophytic; 15–20 ft.; abundant.

*199. Clermontia haleakalensis Rock. Hale-a-ka-la, Maui, only; 7,000 ft.; strongly hygrophytic; 10–20 ft.; very precinctive and rare,.

*200. Cyanea arborea (Gray) Hillebd. Maui only, practically extinct; 4,000-5,000 ft., meso- to xerophytic; 12–25 ft., only one tree known.

*201. Cyanea leptostegia Gray. *Ha-ha-lua;* Kauai only; 2,000–4,000 ft.; mesophytic to semi-hygrophytic; 20–40 ft.

GOODENIACEAE.

*202. Scaevola Chamissoniana Gaud. *Nau-paka;* all islands; 800–5,000 ft. hygrophytic; 15–20 ft., often shrubby.

*203. Scaevola glabra Hook. & Arn. *Ohe-nau-paka;* Kaui, Oahu, West Maui; 3,000–5,000 ft.; strongly hygrophytic; 10–20 ft., usually shrubby.

*204. Scaevola procera Hillebd. *Nau-paka;* Kauai, Molokai, Maui; 2,000–4,000 ft.; hygrophytic; 12–16 ft., usually shrubby.

COMPOSITAE

*205. Dubautia plantaginea Gaud.; *Nae-nae;* all islands; 1,800–6,000 ft.; hygrophytic, sometimes semi-xerophytic; 10–18 ft.

*206. Raillardia arborea Gray. *Nae-nae;* Hawaii, Mauna Kea only, rare; 7,000–11,000 ft.; xerophytic; 18–20 ft., often a small shrub.

*207. Raillardia struthioloides Gray. *Nae-nae;* Hawaii, Mauna Kea only; 7,000–11,500 ft.; xerophytic; 18–25 ft., often a small shrub.

*208. Raillardia Menziesii Gray. *Nae-nae;* Maui, Hale-a-ka-la only; 6,000–10,000 ft.; xerophytic; 15–22 ft., often a shrub.

*209. Hesperomannia arborescens Gray. Hawaiian Tree Thistle; Oahu and Lanai, evidently becoming extinct; 2,000–3,000 ft; hygrophytic; 10–20 ft.

*210. Hesperomannia Lydgatei Forbes; Kauai only, very rare; 3,000 ft.; hygrophytic; 10–20 ft.

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INDEX TO AMERICAN BOTANICAL LITERATURE

1915-1917

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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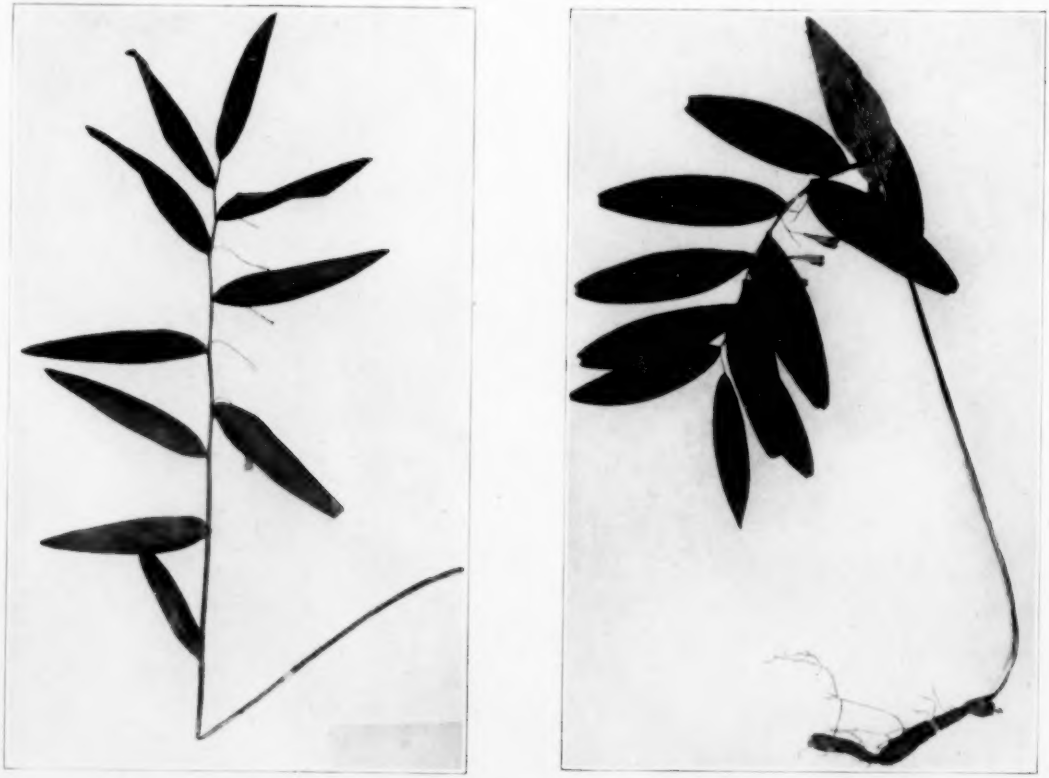
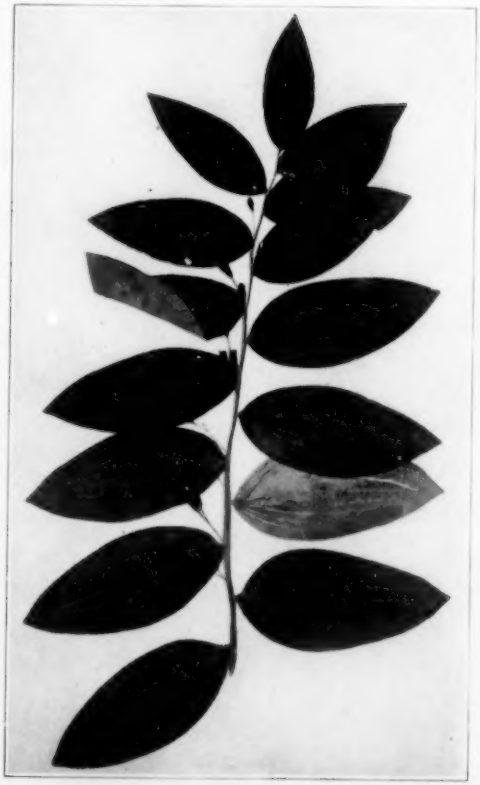
A. POLYGONATUM PUBESCENS AUSTRALE (FARWELL) GATES

B. POLYGONATUM BIFLORUM (WALT.) ELL.



POLYGONATUM BIFLORUM HEBETIFOLIUM GATES



A. POLYGONATUM COMMUTATUM VIRGINICUM (GREENE) GATES

B. POLYGONATUM COBRENSIS (WOOTON & STANDLEY) GATES